AEROLOGICAL OBSERVATIONS

[Aerological Division, D. M. LITTLE in Charge]

By L. P. HARRISON

Mean free-air data based on airplane weather and radiometeorograph observations during the month of February 1938 are given in table 1, which includes the basic elements, barometric pressure, temperature, and relative humidity at various standard geometric heights. "Means," which have been computed by the customary method of differences, are not given where there are less than 15 observations at the surface and less than 5 at the standard heights, except those within the layer of monthly vertical range of the tropopause for which 15 observations are also required. (For further details, see January 1938 Monthly Weather Review, Aerological Observations.)

Chart I shows that the mean *surface* temperatures during February were above normal almost over the entire country. A small area including Montana and part of North Dakota and a separate area in northern California had subnormal surface temperatures.

Table 1 shows that the mean free-air relative humidities in the vicinity of Nashville, Tenn., Spokane, Wash., and the California coast were relatively high on the whole in comparison to those which prevailed over adjacent land areas. They were relatively low at moderate and higher elevations (1.5–5 kilometers) in the vicinity of Pensacola, Fla.

Isobaric charts constructed by use of the mean monthly free-air barometric pressure over the country indicated the location of a statistical center of minimum pressure in the vicinity of Sault Ste. Marie, Mich., and a center of maximum pressure toward the Gulf of Mexico.

Table 2 shows the free-air resultant winds based on pilot-balloon observations made near 5 a. m. (seventy-fifth meridian time) during February. The resultant wind directions were generally close to normal over the greater portion of the country, with notable departures near the west coast, the central and southern Plateau regions and the Florida Peninsula. At Oakland and San Diego, Calif., through the stratum from 0.5 to about 2.5 or 3.0 kilometers, mean sea level, the resultant winds were mostly oriented counterclockwise from normal by amounts ranging from about 140° to 70° over the former station and 100° to 40° over the latter. Similarly, at Seattle, Wash., the amounts of counterclockwise orientation were from about 20° to 135°, and at Spokane, Wash., between 1–3 kilometers, mean sea level, they were about 40° to 65°. However at 4 kilometers, over the latter place, the orientation was 55° clockwise. At 2.5 kilometers, mean sea level, over Medford, Oreg., the orientation was counterclockwise about 50°. Thus along the west coast, the northerly components normal during February were this month replaced by southerly components in the lower levels, and westerly components were more pronounced than usual.

The resultant directions at Salt Lake City, Utah, and Albuquerque, N. Mex., in the layer 2 to 4 kilometers, mean sea level, were oriented counterclockwise from normal by amounts ranging from 20° to 60°, and 20° to 45°, respectively. Here too the southerly components were more pronounced than generally is the case. At Key West, Fla., the monthly resultant directions were rotated counterclockwise from the normal by amounts which increased from 26° at 0.5 kilometer to 248° at 3 kilometers, mean sea level, so that easterly and northerly components were dominant instead of the more usual southerly and westerly components at moderate elevations; i. e., the air resultant flow was from the Atlantic Ocean rather than from the Gulf of Mexico and the Caribbean Sea as has been the general rule in recent years in this region.

The monthly resultant velocities of the free-air winds up to the levels for which data were available were generally in excess of the normal westward of a line running from Vancouver to, say, New Orleans, La., and deficient with respect to the normal eastward of that line, except over the Mississippi and Ohio River valley basin up to 1.5 kilometers, mean sea level, where excesses also prevailed. Most of the departures of resultant velocity from normal fell within the range ±2 meters per second, but in several areas significantly larger departures occurred. In particular, the departures from normal in meters per second at various elevations above sea level were: at 1 kilometer, Oklahoma City, Okla., +3.7, Chicago, Ill., +3.2, Detroit, Mich., −3.8; at 1.5 kilometers, Medford, Oreg., +3.8, Seattle, Wash., +3.2; at 2.0 kilometers, Atlanta, Ga., −3.7; at 2.5 kilometers, Spokane, −4.8, Atlanta, −4.0; at 3.0 kilometers, Spokane, −3.6, Medford, −3.1, Cheyenne, Wyo., −4.0, Pensacola, Fla., −4.6, Boston, Mass. −3.5; at 4 kilometers, Oakland, Calif., +8.1, San Diego, Calif., +4.4, Albuquerque, N. Mex., +4.2, Spokane, −3.6, Pensacola, −3.4; at 5 kilometers, San Diego, +4.8, Albuquerque, +9.4, Atlanta, −5.8.

Table 3 shows the maximum free-air wind velocities and their directions for various sections of the United States during February as determined by pilot balloon observations. The extreme maximum was 61.6 meters per second from the north at 8,600 meters, mean sea level, over Modena, Utah, on February 17.

TABLE 1.—*Mean free-air, barometric pressures (P) in mb., temperatures (T) in ° C., and relative humidities (R. H.) in percent, obtained by airplanes or radiometeorographs during February 1938*

Stations	Altitude (meters) mean sea level																													
	Surface				500			1,000			1,500			2,000			2,500			3,000			4,000			5,000					
	Number of obs.	P	T	R. H.	P	T	R. H.	P	T	R. H.	P	T	R. H.	P	T	R. H.	P	T	R. H.	P	T	R. H.	P	T	R. H.	P	T	R. H.			
Barksdale Field,[1] La. (52 m)	27	1,017	10.4	82	963	10.9	71	907	9.6	63	854	8.6	57	804	6.6	55	755	4.5	54	710	2.9	43	627	−2.9	39						
Billings, Mont.[2] (1,090 m)	25	891	−6.4	75							846	−1.8	60	794	−1.6	55	745	−4.6	55	699	−8.1	57	614	−14.9	58	537	−22.0	56			
*Boston, Mass. (5 m)	25	1,020	−1.4	77	959	−3.1	78	901	−4.1	76	843	−4.8	74	793	−6.3	72	742	−8.1	70	696	−10.1	68	610	−14.7	65	534	20.5	65			
*Burbank, Calif. (220 m)	26	992	6.8	80	958	9.7	68	902	7.1	68	847	3.8	67	798	0.7	65	748	−1.7	60	704	−3.6	56	618	−8.8	55	543	−14.8	53			
Cheyenne, Wyo.[2] (1,873 m)	25	810	−3.8	65										797	−1.4	60	748	−2.5	52	702	−5.8	51	616	12.5	52	540	−18.7	49			
Coco Solo, C. Z.[3] (15 m)	26	1,010	25.5	82	956	21.9	93	903	18.8	91	851	15.7	86	802	13.8	64	756	12.5	46	712	10.2	40	630	5.1	29	558	0.1	13			
El Paso, Tex.[2] (1,194 m)	27	884	7.1	57							851	10.3	45	802	7.7	43	753	4.7	45	708	1.2	47	624	−5.4	47	549	−12.0	43			
Fargo, N. Dak.[2] (274 m)	28	990	−14.1	84	961	−11.9	83	900	−8.1	76	844	−6.6	69	792	−5.8	62	742	−7.1	56	696	−9.2	54	610	−14.7	57	534	−20.5	56			
Kelly Field, Tex.[1] (206 m)	21	998	12.7	77	964	13.0	70	908	11.1	66	855	9.3	64	805	8.8	50	757	6.6	46	712	4.4	41	628	−1.5	39	554	−7.8	34			
Lakehurst, N. J.[3] (39 m)	20	1,020	−0.7	72	963	−0.6	62	904	−0.9	57	849	−2.1	53	797	−4.1	49	747	−5.8	44	701	−8.4	41	615	−14.6	39	539	−21.2	41			
Maxwell Field, Ala.[1] (52 m)	26	1,018	10.6	78	965	11.2	66	908	9.1	66	855	7.0	64	804	5.3	56	756	3.7	46	711	1.4	39	626	−3.9	31	552	−10.1	31			
Mitchel Field, N. Y.[1] (29 m)																															
Nashville, Tenn.[2] (180 m)	28	1,001	7.8	78	963	7.4	77	906	6.0	75	852	5.2	71	801	2.9	68	753	1.1	56	707	−1.3	53	623	−6.7	44	547	−13.2	44			
Norfolk, Va.[3] (10 m)	15	1,026	4.6	78	966	4.5	64	908	2.6	58	853	1.7	52	802	0.3	47	752	−1.0	42	707	−2.7	38	622	−7.1	35	546	−12.2	33			
Oakland, Calif.[3] (2 m)	28	1,017	9.0	86	957	8.6	74	901	5.8	73	847	3.0	69	796	0.0	67	747	−2.6	60	702	−5.1	59	616	−11.0	60	541	−17.7	53			
Oklahoma City, Okla.[2] (391 m)	25	975	4.7	78	962	6.1	72	905	7.1	64	851	6.4	59	801	5.6	48	753	2.9	44	707	0.0	43	623	−6.5	42	548	−13.0	39			
Omaha, Nebr.[2] (300 m)	28	985	−4.1	85	961	−2.6	83	902	0.3	67	848	1.0	56	796	−0.2	51	747	−2.0	44	702	−5.0	43	617	−11.6	44	541	−19.5	48			
Pearl Harbor, T. H.[3] (6 m)	28	1,014	20.6	89	958	20.5	80	903	18.3	74	852	15.9	73	803	13.7	65	756	12.1	51	712	9.9	42	630	5.5	33	557	−0.2	30			
Pensacola, Fla.[3] (13 m)	23	1,023	11.5	82	965	11.9	63	909	10.7	56	855	8.6	51	805	6.9	38	757	5.9	24	712	3.4	22	628	−1.9	18	554	−7.7	16			
St. Thomas, V. I.[3] (8 m)	27	1,018	23.5	72	963	19.3	83	907	15.3	89	854	12.1	86	805	9.9	79	757	9.2	56	713	7.4	44	631	2.4	34	557	−3.2	31			
Salt Lake City, Utah[2] (1,288 m)	28	872	0.4	76							850	1.9	65	798	−0.7	62	748	−4.1	65	703	−7.4	65	616	−13.9	66	540	−20.3	60			
San Diego, Calif.[3] (10 m)	25	1,018	9.4	85	960	11.0	72	904	7.9	68	850	4.6	66	799	1.5	63	750	−0.5	55	705	−2.7	52	620	−7.8	47	546	−14.3	43			
Sault Ste. Marie, Mich.[3] (221 m)	24	997	−9.8	80	961	−11.0	83	901	−10.6	77	844	−10.6	68	790	−11.0	60	740	−11.9	56	693	−13.9	55	606	−18.5	53	529	−24.3	52			
Scott Field, Ill.[1] (135 m)	16	1,005	4.5	84	961	5.3	76	904	5.6	61	850	4.3	58	799	2.6	49	750	0.4	42	705	−2.3	40	620	−8.0	38	546	−14.6	40			
Seattle, Wash.[2] (10 m)	16	1,009	4.2	80	951	4.5	67	893	2.0	64	839	−1.1	63	788	−3.7	57	740	−6.6	52	696	−9.8	47	613	−17.1	46						
Selfridge Field, Mich.[1] (177 m)	24	1,001	−2.9	84	961	−4.5	85	902	−5.4	81	846	−4.2	61	794	−5.4	62	744	−6.8	56	698	−8.8	51	612	−13.8	46	536	−20.3	43			
Spokane, Wash.[3] (597 m)	28	944	−1.1	90				898	−0.9	87	843	−2.2	82	792	−4.9	78	742	−7.8	77	696	−10.7	72	609	−17.9	70	532	−25.3	68			
Washington, D. C.[3] (13 m)	21	1,025	1.9	76	965	1.6	66	907	−0.1	63	852	−0.6	60	800	−1.1	56	751	−2.5	47	705	−4.8	44	619	−11.0	49	543	−17.0	47			
Wright Field, Ohio[1] (244 m)																															
Chicago, Ill.[2] (187 m)	28	999	0.8	83	962	−0.3	86	903	−0.6	79	848	−0.2	67	796	−1.2	60	747	−3.3	57	701	−5.7	57	616	−10.6	52	540	−16.7	47			

Stations	Altitude (meters) mean sea level)																													
	6,000			7,000			8,000			9,000			10,000			11,000			12,000			13,000			14,000					
Boston, Mass.	465	−27.0	62	403	−33.9	57	350	−41.1	56																					
Burbank, Calif.	475	−21.2	52	415	−27.5	52	359	−34.2	52	312	−40.5	52	268	−48.9																

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Stations	Altitude (meters) mean sea level																													
	Surface				500			1,000			1,500			2,000			2,500			3,000			4,000			5,000					
	Number of obs.	P	T	R. H.	P	T	R. H.	P	T	R. H.	P	T	R. H.	P	T	R. H.	P	T	R. H.	P	T	R. H.	P	T	R. H.	P	T	R. H.			
St. Thomas, V. I.[3] (8 m)	30	1,018	24.3	76	962	20.5	87	907	16.7	92	854	13.6	91	805	11.1	83	758	11.5	47	713	10.1	27	632	4.4	18	559	−1.8	13			

*Observations by radiometeorograph. Stations not so marked have observations by airplane. [1] Army. [2] Weather Bureau. [3] Navy.

Observations taken about 4 a. m. 75th meridian time, except by Navy stations along the Pacific coast and Hawaii where they are taken at dawn.

NOTE.—None of the means included in this table are based on less than 15 surface or 5 standard-level observations, except those levels comprised within the layer in which the tropopause occurred, where at least 15 are also required as a basis.

TABLE 2.—*Free-air resultant winds (meters per second) based on pilot-balloon observations made near 5 a. m. (E. S. T.) during February 1938*

[Wind from N=360°, E=90°, etc.]

Altitude (meters) m. s. l.	Albuquerque, N. Mex. (1,554 m)		Atlanta, Ga. (309 m)		Billings, Mont. (1,088 m)		Boston, Mass. (15 m)		Cheyenne, Wyo. (1,873 m)		Chicago, Ill. (192 m)		Cincinnati, Ohio (156 m)		Detroit, Mich. (204 m)		Fargo, N. Dak. (283 m)		Houston, Tex. (21 m)		Key West, Fla. (11 m)		Medford, Oreg. (410 m)		Nashville, Tenn. (184 m)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°		°	
Surface	348	0.9	346	1.2	259	1.3	304	2.4	271	3.0	232	0.3	289	0.6	339	1.0	10	1.5	12	1.1	46	2.6	351	0.2	211	1.3
500			19	0.7			290	7.4			255	2.9	237	3.4	238	1.9	339	0.4	234	0.8	81	6.6	81	0.5	216	4.9
1,000			273	1.5			315	7.6			259	11.0	243	10.0	236	4.5	257	3.7	247	3.0	99	5.4	148	4.2	240	7.9
1,500			283	4.7	235	5.4	319	8.2			279	10.5	251	9.4	265	8.0	269	3.8	259	4.2	96	4.5	171	7.0	268	7.8
2,000	243	2.5	276	5.4	262	5.3	309	11.2	272	4.6	300	10.3					285	7.0	297	6.9	79	3.1	197	7.0	272	6.7
2,500	247	5.6	279	5.9	275	5.7	306	13.9	266	6.5							297	10.3	296	7.1	36	1.9	206	5.5		
3,000	246	9.2	284	5.9	281	7.2	302	10.7	275	8.1							290	9.5	301	11.1	13	1.6	290	1.1		
4,000	248	15.5	284	9.8	271	8.9			269	8.6									286	13.1						
5,000	248	21.2	282	11.4																						

TABLE 2.—*Free-air resultant winds (meters per second) based on pilot-balloon observations made near 5 a. m. (E. S. T.) during February 1938*—Continued

[Wind from N=360°, E=90°, etc.]

Altitude (meters) m. s. l.	Newark, N. J. (14 m)		Oakland, Calif. (8 m)		Oklahoma City, Okla. (402 m)		Omaha, Nebr. (306 m)		Pearl Harbor, Territory of Hawaii[1] (68 m)		Pensacola, Fla.[1] (24 m)		St. Louis, Mo. (170 m)		Salt Lake City, Utah (1,294 m)		San Diego, Calif. (15 m)		Sault Ste. Marie, Mich. (198 m)		Seattle, Wash. (14 m)		Spokane, Wash. (603 m)		Washington, D. C. (10 m)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°		°	
Surface	327	2.5	141	2.7	262	0.3	350	1.8	10	1.0	27	2.9	237	1.6	151	4.0	75	0.7	76	1.7	133	1.0	104	1.1	305	1.6
500	308	6.0	202	2.8	200	2.4	333	1.8	158	1.1	63	2.4	237	4.4	-----	-----	225	0.4	93	2.1	154	3.5	-----	-----	289	5.4
1,000	306	8.8	229	4.8	232	8.4	287	5.1	199	1.3	298	2.6	259	7.6	-----	-----	251	0.7	317	3.1	180	5.2	134	2.3	300	7.3
1,500	302	10.9	243	4.9	250	7.7	291	6.2	219	2.2	319	4.1	279	9.7	161	5.0	197	1.3	312	6.1	184	7.0	204	3.4	292	10.2
2,000	311	12.9	252	4.9	265	8.9	295	7.4	233	3.3	303	5.1	272	10.1	181	5.2	228	3.2	321	7.5	174	4.9	219	4.1	291	10.9
2,500	299	10.2	256	4.3	265	9.3	290	9.1	266	3.6	296	5.2	300	11.2	199	4.8	253	4.1	318	8.6	165	5.4	231	2.6	289	12.5
3,000	-----	-----	307	5.9	267	8.2	281	9.8	276	5.6	304	3.0	285	11.5	215	5.5	256	7.1	320	12.1	154	4.7	219	2.6	292	13.2
4,000	-----	-----	324	12.9	277	10.7	255	8.6	257	4.0	302	5.3	-----	-----	224	6.4	285	10.9	-----	-----	-----	-----	346	2.0	-----	-----
5,000	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	286	10.3	-----	-----	-----	-----	-----	-----	-----	-----

[1] Navy stations.

TABLE 3.—*Maximum free-air wind velocities (meters per second), for different sections of the United States based on pilot balloon observations during February 1938*

Section	Surface to 2,500 meters (m. s. l.)					Between 2,500 and 5,000 meters (m. s. l.)					Above 5,000 meters (m. s. l.)				
	Maximum velocity	Direction	Altitude (m), m. s. l.	Date	Station	Maximum velocity	Direction	Altitude (m), m. s. l.	Date	Station	Maximum velocity	Direction	Altitude (m), m. s. l.	Date	Station
Northeast [1]	42.1	NNW	2,500	28	Kylertown	52.1	NNW	2,950	28	Kylertown	33.2	NW	5,850	7	Columbus.
East Central [2]	40.8	NW	1,900	28	Washington	42.8	NW	3,060	28	Greensboro	36.4	WNW	8,130	7	Knoxville.
Southeast [3]	36.0	WNW	1,560	27	Charleston	35.6	WNW	4,530	28	Charleston	37.6	NW	10,000	1	Key West.
North Central [4]	40.2	NNW	2,330	26	Minneapolis	42.8	NW	3,610	26	Fargo	38.0	WNW	5,590	9	Fargo.
Central [5]	42.2	WSW	1,890	6	Moline	39.0	NW	2,930	27	Evansville	36.8	WSW	5,560	13	Wichita.
South Central [6]	33.2	SSW	1,390	1	Oklahoma City	37.0	WSW	3,370	5	Oklahoma City	36.4	WNW	6,970	25	Amarillo.
Northwest [7]	46.2	SSW	2,300	5	Medford	40.2	WSW	5,000	7	Boise	46.0	NNW	7,130	15	Portland.
West Central [8]	37.0	SE	810	9	Sacramento	38.0	SSW	2,800	10	Sacramento	61.6	N	8,600	17	Modena.
Southwest [9]	31.5	SW	1,180	6	Havre	39.0	WSW	5,000	4	Albuquerque	59.0	NNW	10,540	17	Las Vegas.

[1] Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, and northern Ohio.
[2] Delaware, Maryland, Virginia, West Virginia, southern Ohio, Kentucky, eastern Tennessee, and North Carolina.
[3] South Carolina, Georgia, Florida, and Alabama.
[4] Michigan, Wisconsin, Minnesota, North Dakota, and South Dakota.
[5] Indiana, Illinois, Iowa, Nebraska, Kansas, and Missouri.
[6] Mississippi, Arkansas, Louisiana, Oklahoma, Texas (except El Paso), and western Tennessee.
[7] Montana, Idaho, Washington, and Oregon.
[8] Wyoming, Colorado, Utah, northern Nevada, and northern California.
[9] Southern California, southern Nevada, Arizona, New Mexico, and extreme west Texas.

RIVERS AND FLOODS

[River and Flood Division, MERRILL BERNARD in Charge]

By BENNETT SWENSON

Precipitation during February was heavy over most of a wide belt extending from Texas and New Mexico northeastward over the Lake region, and also in nearly all of the Pacific slope area. The relatively heaviest amounts occurred in California and the lower Great Plains where the rainfall was from 200 to 400 percent or more of the normal. On the other hand, in the South Atlantic slope and East Gulf of Mexico drainage area, it was one of the driest months of February of record.

The principal floods during February occurred in the rivers in Michigan, southern Wisconsin, and Illinois, the Meramec River in Missouri, the Wabash-White Rivers in Indiana, the White Basin in Missouri and Arkansas, the Arkansas and Red Basins, the St. Francis River in Missouri and Arkansas, the Trinity River in Texas, and in the San Joaquin and Sacramento Rivers in California.

St. Lawrence drainage.—Heavy rains in Michigan on February 5 and again on the 12th–13th caused two sharp rises in the Grand and Saginaw River systems and other small streams in southern Michigan. The snow cover was not excessive and did not have an appreciable effect on the flood, but the mild temperature and rain caused the solid ice in the rivers to break up and resulted in ice jams that caused increased overflow.

The storm of February 12–13 broke all records for maximum short period rainfall, as well as for the 24-hour period for February at several points. The greatest amount occurred at East Lansing, Mich., where 4.33 inches occurred within 24 hours. This is the greatest of record at that point for the month of February or any winter month, and for any month in the past 33 years.

The intensity of the rainfall and presence of ice in the streams produced sudden rises that gave little time for warnings except in the lower portions of the streams. Damages have been estimated as follows: Grand River, $95,200; Saginaw River, $22,800; other rivers in southeastern Michigan, $119,350.

Atlantic slope drainage.—A severe local flood occurred in the Mohawk River at Amsterdam, N. Y., on February 7–8. The river rose 10.3 feet in 24 hours on February 6–7, due to moderate rains and high temperatures which caused moderately heavy run-off in the tributaries of the Mohawk River. In the meantime, the ice that had moved out of the Schoharie River on January 25 and had moved slowly